OPTIMIZING USE OF DISTILLER'S GRAINS WITH SOLUBLES (DGS) IN FINISHING CATTLE DIETS

B. E. Depenbusch, J. S. Drouillard, E. R. Loe, M. E. Corrigan, and M. J. Quinn

Introduction

Rapid expansion of the fuel ethanol industry has increased availability of distillery byproducts. Distiller's grains with solubles (DGS) are the predominant byproduct of fermenting grains to fuel ethanol. During this process, the majority of starch is removed from the grain, and residual components of the grain are concentrated into the distiller's byproduct. Distiller's grains with solubles contain the bran, which is high in fiber; the germ, which is high in fat; and the protein. Given the relatively high fiber content of DGS, it is conceivable that DGS could serve as a replacement for roughage in finishing diets.

One of the major expenses incurred with production of distiller's byproducts is the energy needed to dehydrate byproducts to acceptable moisture levels. Moisture content is critically important because it directly impacts transportation costs, storage characteristics, and handling properties of the feed. Dehydration of byproducts also may alter the nutritive value of the DGS. Generally speaking, extensive heating can result in the formation of indigestible complexes between carbohydrates and proteins, potentially reducing energy availability and efficiency of nitrogen utilization. Consequently, there is significant potential for creating differences in nutritional value of DGS as a result of drying.

Corn and sorghum are the predominant grains used for ethanol production in the United States. The type of grain used is largely determined by the geographical location of the ethanol plant. For example, sorghum grain frequently is produced as a dryland crop in low rainfall areas of the Plains, and corn is produced in the High Plains and Corn Belt regions. In some regions, both corn and sorghum DGS may be available for use in livestock feeding; however, relatively little data is available pertaining to comparative nutritional values of DGS derived from corn and sorghum.

The objectives of this study were to compare 1) sorghum-based DGS with corn-based DGS, 2) wet DGS with dry DGS, and 3) performance of cattle fed diets containing DGS with and without added roughage.

Experimental Procedures

Two hundred and ninety-nine crossbred-yearling steers (800 lb) were obtained from a common source and used in a finishing study. Upon arrival at the feedlot, steers were offered *ad libitum* access to long-stemmed prairie hay and fresh water. Two days after arrival, cattle were identified with uniquely numbered ear tags in both ears and received injections of Bovishield 4 and Fortress-7 vaccines. One week later, animals were revaccinated with

[1]Revalor is a registered trademark of Intervet, Inc.

Bovishield 4, administered Phoenectin pour-on, and implanted with Revalor[1] IS growth implants. Sixty-seven days after the first implant, steers were re-implanted with Revalor IS. Steers were housed in 49 concrete-surfaced pens (392 ft^2) with overhead shade covering the bunk and half of the pen. Pens included an automatic water fountain and 10.5 linear feet of bunk space. Finishing diets were formulated to be isonitrogenous at 14% crude protein. Distiller's grains with solubles were added to the diets at 15% on dry matter basis and alfalfa hay was added at 6% on dry matter. Finishing diets are further described in Table 1. Yearling steers were harvested on two different days (day 101 and day 132) with average days on feed of 116 days. Cattle were shipped to a commercial abattoir in Emporia, KS, where carcass data were collected. Hot carcass weight and liver abscess scores were obtained at the time of harvest. Measurements taken following a 24-hour chill were ribeye area; subcutaneous fat thickness over the 12^{th} rib; kidney, pelvic, and heart fat; marbling score; USDA quality grades; and USDA yield grades. Final body weight was calculated by dividing hot carcass weight by a common dressing percentage of 63.5.

Apparent total tract digestibility of dry matter and organic matter were determined for 21 pens (three pens/treatment) over a 72-hour period during the finishing phase. On day 115, prior to the daily feeding, feed that had not been consumed by the steers was removed, and concrete pen surfaces were thoroughly cleaned. After 24, 48, and 72 hours, feces were collected from each pen, weighed, and a representative sample (~2%) collected from each pen. Daily samples from each pen were composited and frozen for subsequent analysis. Daily feed refusals were also collected at 24, 48, and 72 hours, weighed, and samples were retained for analysis. Samples of feed ingredients, feed refusals, and feces were analyzed for dry matter and organic matter content. Apparent total tract dry matter digestibility was calculated as: [1 – (fecal dry matter output/dry matter intake)] × 100% and apparent total tract organic digestibility as [1 – (fecal organic matter output/organic matter intake)] × 100%.

Results

Addition of 15% DGS had no significant effect on dry matter intake, average daily gain, feed efficiency, or final body weight. However, apparent total tract digestibility of dry matter and organic matter were reduced by approximately 3% ($P<0.05$) when DGS were added to the diet. In addition, steers fed DGS had significantly lower dressing percentages. Observed values were not significantly different among diets with and without 15% DGS for ribeye area; marbling score; kidney, pelvic, and heart fat; 12th rib fat thickness; and USDA quality and yield grades.

Distiller's grains with solubles derived from corn and sorghum resulted in similar growth performance and apparent total tract digestibilities for dry matter and organic matter. However, steers fed the corn DGS tended to be more efficient than the steers fed sorghum based DGS. Generally speaking, carcass characteristics did not differ between steers fed corn-based or sorghum-based DGS. However, steers fed corn-based DGS did have a higher dressing percentage than steers fed sorghum-based DGS.

Steers fed dried DGS tended to consume less feed and were not as efficient when compared to the steers fed wet DGS. Average daily gain, apparent total tract digestibility for dry matter and organic matter, and carcass characteristics were not significantly different between wet and dried DGS. However, steers fed wet DGS had a higher dressing percentage compared to steers fed dried DGS ($P<0.05$).

Dry matter intake and average daily gains decreased in response to removing alfalfa hay from the diet, but feed efficiency was not affected. Apparent total tract digestibility for dry matter and organic matter improved by approximately 4% when alfalfa hay was removed from the diet. Steers fed 6% hay had poorer dressing percentages than steers fed diets without hay. There were no differences between treatments for marbling score; percent USDA Choice or better carcasses; ribeye area; kidney, pelvic, and heart fat; and liver abscesses.

Implications

This study suggests that the addition of 15% DGS to flaked-corn finishing diets reduced overall diet digestibility. Sorghum-based and corn-based DGS have comparable nutritional value for feedlot cattle when added to finishing diets at 15% of dry matter. Likewise, wet DGS and dry DGS are comparable feed ingredients. Distiller's grains with solubles are not suitable as a replacement for all of the dietary roughage.

Table 1. Composition of Finishing Diets (% of dry matter)

		Sorghum Dry DGS		Sorghum Wet DGS[a]		Corn DGS (6% Hay)	
Item	Control	0% Hay	6% Hay	0% Hay	6% Hay	Dry	Wet
Ingredient							
Steam-flaked corn	81.1	75.7	70.0	75.3	69.8	69.8	69.8
DGS	-	15.0	15.0	15.0	15.0	15.0	15.0
Concentrated separator byproduct	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Alfalfa hay	6.0	-	6.0	-	6.0	6.0	6.0
Limestone	1.9	3.5	3.2	3.2	3.0	3.0	3.0
Soybean meal	4.2	-	-	-	-	-	-
Urea	1.4	-	-	0.8	0.6	0.5	0.5
Supplement[a]	0.4	0.8	0.8	0.7	0.6	0.7	0.7
Nutrient %, calculated							
Dry matter	82.2	82.7	83.1	66.5	66. 8	83.0	68.6
Crude protein	14.0	14.4	14.0	14.0	14.0	14.0	14.0
Fat	3.8	4.6	4.5	4.9	4.8	4.8	4.7
Calcium	0.7	0.7	0.7	0.7	0.7	0.7	0.7
Phosphorus	0.3	0.3	0.3	0.4	0.4	0.3	0.4

[a]Formulated to provide 300 mg Rumensin[2] and 90 mg Tylan[2] per steer daily.

[2]Rumensin and Tylan are registered trademarks of Elanco Animal Health, Indianapolis, IN.

Table 2. Growth Performance of Yearling Steers

		Sorghum Dry DGS		Sorghum Wet DGS		Corn DGS (6% Hay)			Contrast[z]			
Item	Control	0% Hay	6% Hay	0% Hay	6% Hay	Dry	Wet	SEM	1	2	3	4
No. of head	43	43	41	43	42	44	43	-			-	-
No. of pens	7	7	7	7	7	7	7	-			-	-
Days on feed	114	114	114	114	114	114	114	-			-	-
Initial weight, lb	803	798	802	803	804	792	800	32.4	0.61	0.24	0.32	0.69
Final weight, lb[y]	1155[a]	1100[b]	1150[a]	1134[a]	1142[a]	1149[a]	1146[a]	24.6	0.47	0.94	0.37	0.01
Dry matter intake, lb/day	20.6[a]	19.1[b]	21.1[a]	19.2[b]	20.7[a]	20.9[a]	20.3[a]	0.59	0.64	0.22	0.13	0.01
Average daily gain, lb/day	3.18[a]	2.70[b]	3.11[a]	2.98[a]	3.03[a]	3.19[a]	3.11[a]	0.10	0.49	0.43	0.61	0.01
Feed:gain	6.49[a]	7.06[b]	6.77[ab]	6.45[a]	6.80[ab]	6.54[a]	6.53[a]	0.16	0.33	0.12	0.14	0.78
Apparent digestibility, %												
Dry matter	83.8[bc]	83.9[cd]	82.6[abc]	86.4[d]	80.1[a]	81.2[ab]	82.0[abc]	0.90	0.03	0.79	0.74	0.01
Organic matter	86.8[cd]	86.4[bc]	85.2[abc]	89.0[d]	83.4[a]	84.0[ab]	85.0[abc]	0.85	0.02	0.79	0.39	0.01

[abcd]Means within a row that do not share similar superscripts are different (P<0.05).

[y]Carcass adjusted final weight was calculated by dividing carcass weight by a common dress yield of 63.5%.

[z]Orthogonal contrast:

1 = Control vs. DGS; (Control vs. sorghum dry DGS with hay, sorghum wet DGS with hay, corn dry DGS, and corn wet DGS).

2 = Sorghum DGS vs. Corn DGS; (Sorghum dry DGS with hay and sorghum wet DGS with hay vs. corn dry DGS and corn wet DGS),

3 = Wet DGS vs. Dry DGS; (Sorghum wet DGS with hay, sorghum wet DGS without hay, and corn wet DGS vs. sorghum dry DGS with hay, sorghum dry DGS without hay, and corn dry DGS),

4 = Sorghum DGS with hay vs. Sorghum DGS without hay; (sorghum dry DGS with hay and sorghum wet DGS with hay vs. sorghum dry DGS without hay and sorghum wet DGS without hay).

Table 3. Carcass Characteristics of Yearling Steers Fed Various Steam-flaked Corn Based Finishing Diets

		Sorghum Dry DGS		Sorghum Wet DGS		Corn DGS (6% Hay)			Contrast[z]			
Item	Control	0% Hay	6% Hay	0% Hay	6% Hay	Dry	Wet	SEM	1	2	3	4
Hot carcass weight, lb	734[a]	698[b]	731[a]	720[a]	725[a]	729[a]	727[a]	15.6	0.47	0.94	0.37	0.01
Dressing percentage	61.3[c]	60.6[ab]	60.3[a]	61.3[c]	60.6[ab]	61.1[bc]	61.3[c]	0.2	0.03	0.01	0.01	0.01
Ribeye area, sq inches	13.0[b]	12.2[a]	12.7[ab]	12.8[b]	12.6[ab]	12.8[b]	12.7[ab]	0.27	0.18	0.52	0.44	0.51
Kidney, pelvic, and heart fat, %	2.7[ab]	2.6[a]	2.7[ab]	2.7[ab]	2.7[ab]	2.8[b]	2.7[ab]	0.06	0.70	0.58	0.32	0.50
12th rib fat, inches	0.45[ab]	0.43[ab]	0.50[a]	0.42[b]	0.47[ab]	0.44[ab]	0.49[ab]	0.03	0.35	0.46	0.92	0.03
USDA yield grade												
YG 1, %	13.3	4.4	7.1	14.3	4.4	4.1	4.8	0.04	0.10	0.76	0.47	0.42
YG 2, %	46.6[ab]	65.0[a]	42.4[ab]	49.3[ab]	40.3[b]	64.0[ab]	48.0[ab]	0.09	0.83	0.09	0.11	0.07
YG 3, %	37.8[ab]	25.9[a]	45.2[ab]	34.4[ab]	52.5[b]	29.6[a]	40.1[ab]	0.08	0.65	0.09	0.19	0.02
YG 4, %	2.4	4.8	2.4	2.0	2.9	2.4	7.1	0.03	0.61	0.35	0.65	0.73
YG 5, %	0.0	0.0	2.9	0.0	0.0	0.0	0.0	0.01	0.56	0.19	0.29	0.19
Average YG, %	2.29	2.31	2.51	2.24	2.54	2.30	2.50	0.12	0.22	0.31	0.62	0.05
USDA quality grade												
Prime, %	4.8[a]	0.0[b]	0.0[b]	0.0[b]	0.0[b]	0.0[b]	0.0[b]	0.01	0.01	1.00	1.00	1.00
Choice, %	76.2	67.4	75.7	69.7	70.1	79.3	74.2	0.09	0.85	0.57	0.61	0.52
Select, %	19.0	32.6	24.3	27.9	29.9	20.7	23.5	0.09	0.46	0.46	0.83	0.64
No roll, %	0.0	0.0	0.0	2.4	0.0	0.0	2.3	0.01	0.65	0.31	0.10	0.31
Marbling score[y]	474[a]	441[ab]	458[ab]	431[b]	447[ab]	458[ab]	458[ab]	15.6	0.20	0.67	0.51	0.21
Liver abscess, %	2.4	2.5	4.8	7.2	0.1	2.4	2.4	3.16	1.00	0.99	0.99	0.41

[abc]Means within a row that do not share similar superscripts are different (P<0.05).

[y]300 to 399 = Select, 400 to 499 = Choice, 500 to 599 = Prime

[z]Orthogonal contrasts:

1 = Control vs. DGS; (Control vs. sorghum dry DGS with hay, sorghum wet DGS with hay, corn dry DGS, and corn wet DGS),

2 = Sorghum DGS vs. Corn DGS; (Sorghum dry DGS with hay and sorghum wet DGS with hay vs. corn dry DGS and corn wet DGS),

3 = Wet DGS vs. Dry DGS; (Sorghum wet DGS with hay, sorghum wet DGS without hay, and corn wet DGS vs. sorghum dry DGS with hay, sorghum dry DGS without hay, and corn dry DGS),

4 = Sorghum DGS with hay vs. Sorghum DGS without hay; (sorghum dry DGS with hay and sorghum wet DGS with hay vs. sorghum dry DGS without hay and sorghum wet DGS without hay).